

STERILIZATION ASSEMBLY DEVELOPMENT LABORATORY

A Study of the Microbial Burden Accumulated
on Assemblies Built in EASL under Disrupted
Vertical Airflow

Task 12.0
15 August 1967

JPL Contract 951624 - Phase II

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PREPARED: E. M. Hajema
E. M. Hajema
AVCO CORPORATION

APPROVED: E. A. Botan
E. A. Botan - Microbiology Manager
AVCO CORPORATION

APPROVED: E. J. Lunney
E. J. Lunney - CSO Manager
AVCO CORPORATION

APPROVED: W. Paik
W. Paik - Sterilization
JET PROPULSION LABORATORY

APPROVED: G. H. Redmann
G. H. Redmann - SADL Project Manager
JET PROPULSION LABORATORY

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

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Final Report

Task 12

A Study of the Microbial Burden Accumulated on Assemblies Built in EASL Under Conditions of Disrupted Vertical Laminar Downflow

I. Introduction

The purpose of Task 12 was to determine the effects of disrupting laminar downflow in the EASL assembly facility on the microbial burden accumulated on hardware assemblies. The normal specified¹ environment was maintained in EASL with regard to temperature ($70^{\circ}\text{C} \pm 10^{\circ}\text{C}$), humidity ($45\% \pm 5\%$) and air velocity ($75\text{ ft./min.} \pm 20\text{ ft./min.}$), but the downflow was disrupted through the use of a 30° aluminum cone 6 ft. in diameter and 3 ft. high. The effect of this disruption on accumulated microbial burden during assemblies was demonstrated under the following conditions:

1. Normal EASL environment - condition A
2. Assembler and worktable under center of the cone - condition B
3. Assembler under cone; worktable under edge of cone - condition C
4. Same arrangement as in condition C with horizontal laminar airflow directed over the worktable toward the assembler - condition D. Conditions B, C, and D are illustrated in Figure 1. To determine the effect of these conditions on the burden, three sequential timers (Fig. 2) were built under each set of conditions, including normal environment as a control.

II. Materials and Methods

A. Environmental Sampling

1. Intramural Air - Reynier air samplers were located in the assembly area as in Figure 1 for each set of environmental conditions. Air samples were collected 1/2 hour before, once each hour during, and for 1/2 hour following each 4-hour assembly period.

2. Microbial Fallout - Two trays of stainless steel fallout strips were placed as shown in Fig. 1 for each assembly. Three strips were collected from each tray immediately after they were exposed in EASL, and three strips during each hour of the assembly period, for bioassay.

3. Worktable Surface Microbial Burden - Rodac impression plates were used to sample the surface of the worktable before, and three times during each assembly. Sampling sites are shown in Fig. 1.

4. Microbial Burden under Area of Cone. Stainless steel strips 1" x 2" x .015"* were attached to the inside surface of the cone as shown in Fig. 3. During each assembly a total of 36 coupons were removed for bioassay. The selection of coupons for determination of microbial burden was based on the air flow pattern under the cone. This flow pattern was demonstrated by observing the dispersal of titanium^{tetra}chloride smoke. (A 16 mm color film of the smoke test was made.)

5. Microbiological assays of fallout strips and coupons, as well as incubation of Reynier and Rodac plates, were done according to NASA Standard Procedures.²

B. Preparation of Supplies

All timer parts and tools for the assemblies were decontaminated in ETO prior to assembly. Supplies for environmental sampling and

*This thickness strip used to allow strip to be fitted to slightly curved surface.

microbiological assays were prepared and sterilized prior to use according to NASA Standard Procedures² for each type of material.

C. Personnel Clothing Requirements - For assembly and disassembly of the timers, personnel were required to wear sterile gowns, hoods, masks, and rubber gloves.

D. Assembly Procedure and Sequence of Construction - see Appendix A.

E. Disassembly Procedure - See Appendix B.

F. Parts List and Assay Groups - See Appendix C

All procedures involved in assembly and disassembly were monitored and logged by Quality Assurance personnel.

III. Results

The microbial burden of the intramural air as monitored by Reynier samplers is shown in Table 1. The values recorded include bacterial and fungal colonies as viable particles/ft.³ of intramural air. The surface burden on the worktable as demonstrated using Rodac plates is recorded in Table 2 as colonies/rodac plate. Table III lists the viable particles/ft.² of surface as determined from the fallout strips. The microbial burden on the coupons from the underside of the cone is listed in Table 4 as viable particles/coupon. Table 5 contains the microbial counts from the timer parts assay groups. Table 6 shows the statistical relationships among the intramural air microbial burden samples under each set of EASL environmental conditions.

IV. Discussion

The data showed increases in microbial burden in the environment (Table 1) and on the worktable surface (Table 2) during conditions

of disrupted downflow, especially when both the assembler and the worktable were under the center of the cone. (Condition B). The addition of the horizontal laminar flow directed towards the worktable decreased the surface burden, and the intramural air burden when the individual sampling values are considered, especially in the areas outside the cone. In this case, however, there was a significant increase in the burden collected from the air sampler to the rear of the assembler, under the cone. This increased burden probably represents that burden washed off the worktable and the assembler by the horizontal airflow. Although the individual values obtained from intramural air samples outside the cone with the added horizontal laminar flow were lower than those in the absence of this type of airflow a statistical analysis of the data revealed no significant difference in intramural air burden between the two sets of environmental conditions. All experimental environmental variations showed a significant increase in intramural air microbial burden in comparison to the data obtained under normal EASL facility conditions.

Occasional difficulty in either assembling or disassembling the timers as well as skin exposure resulting from torn gloves may have contributed to the burden found on the timer assay groups.

V. Conclusions

1. The microbial burden of the intramural air was significantly increased during the assemblies carried out under all the experimental conditions of disrupted vertical laminar downflow.

VI. Recommendations

1. Add a source of horizontal laminar airflow onto the work surface during the construction of hardware under conditions of disrupted vertical laminar downflow.

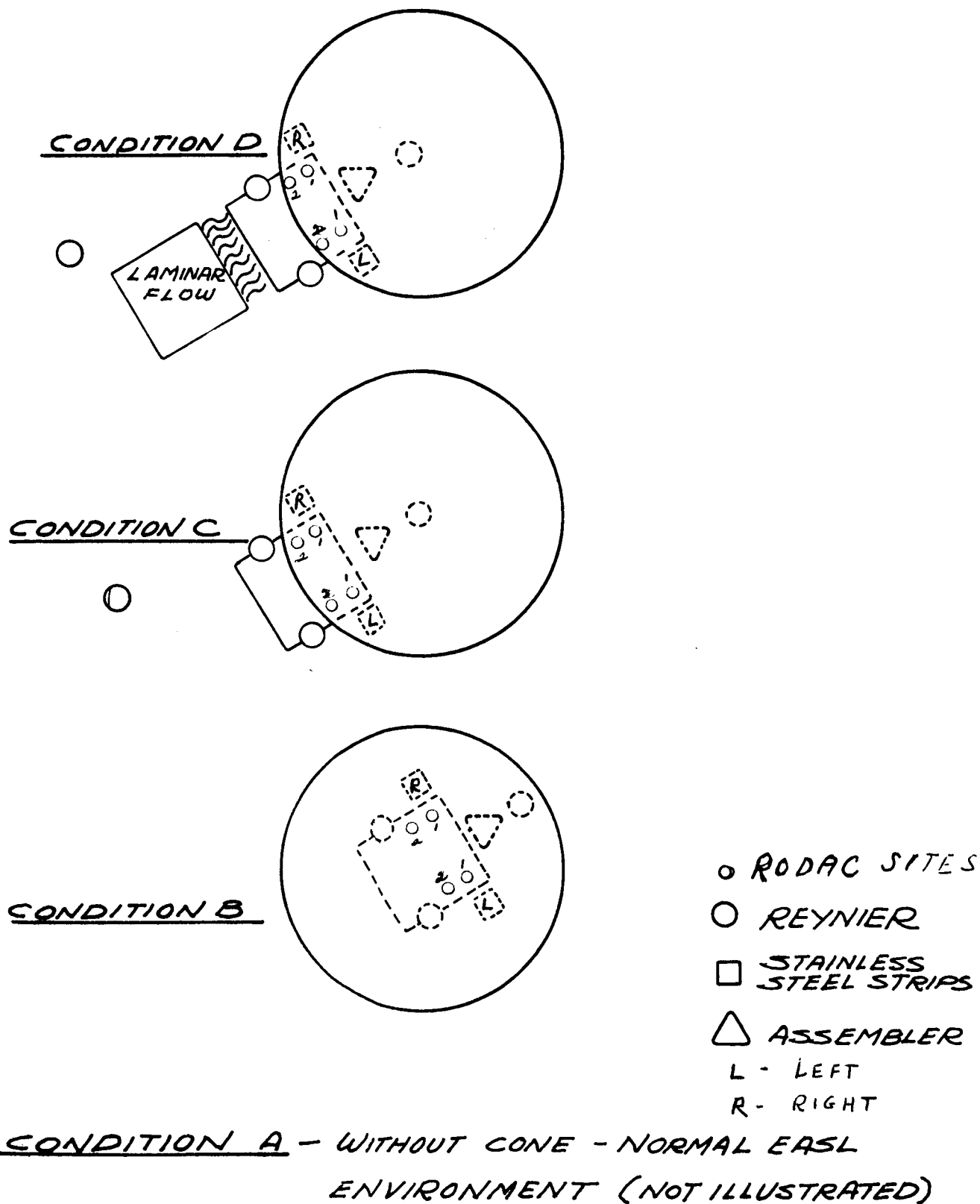
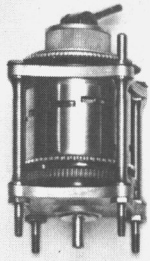


FIG. 1

ASSEMBLY ROOM SET UP FOR TASK 12 -
DISRUPTION OF VERTICAL DOWNFLOW OF AIR -
CONDITIONS B, C & D



PT.# 300 TIMER

PT.# 300 TIMER ASSY

PT.# 280



PT.# 290



PT.# 285



PT.# 295



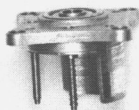
PT.# 230



PT.# 215



PT.# 100 HOUSING SUB-ASSY



PT.# 90



PT.# 40



PT.# 60

PT.# 50



PT.# 100



PT.# 200



PT.# 275



PT.# 265



PT.# 255



PT.# 260



PT.# 250



PT.# 245



PT.# 240



PT.# 235



PT.# 230



PT.# 225



PT.# 220



PT.# 215



PT.# 210



PT.# 205



PT.# 200



PT.# 195



PT.# 190



PT.# 185



PT.# 180



PT.# 175



PT.# 170



PT.# 200 SHAFT SUB-ASSY



PT.# 150



PT.# 160



PT.# 170



PT.# 180



PT.# 190



PT.# 140



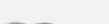
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PT.# 110



PT.# 100



PT.# 90



PT.# 80



PT.# 70



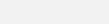
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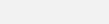
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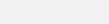
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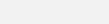
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PT.# 20



PT.# 10



PT.# 0

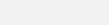


Figure 2 - Assembled Timer and Parts Breakdown.

CONE SHIELD (FOR DISRUPTED AIR FLOW)

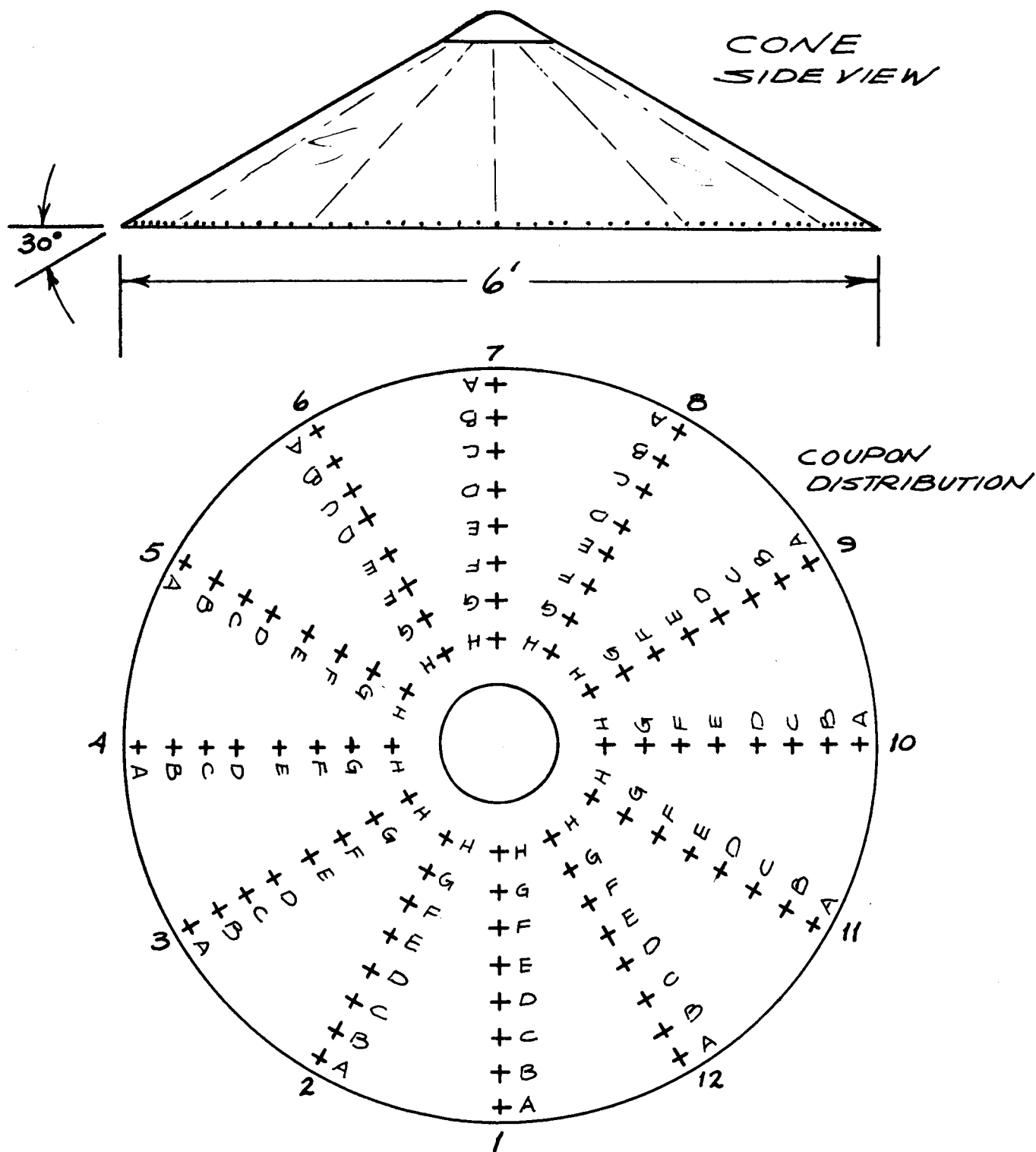


FIGURE 3. CONE VIEW LOOKING DOWN (OUTSIDE SURFACE)
COUPON PLACEMENT AS SHOWN, ON UNDER SIDE
SURFACE

Table 1

Microbial Burden in Intramural Air of EASL Facility
Reynier Air Sampler

Samp- ling Site*	Samp- ling Time	3 VIABLE PARTICLES/FT INTRAMURAL AIR - AEROBIC MESOPHILES											
		CONDITION A*			CONDITION B			CONDITION C			CONDITION D		
		1	2	3	4	5	6	7	8	9	10	11	12
Left	1/2 before	0	No Sample	0	0	0	.06	0	0	0	0	0	0
	1st hr.	0	0	0	.08**	/	0	0	0	0	0	0	0
	2nd "	0	0	0	.02	.02	.05	.03	.02	0	0	0	0
	3rd "	0	.02	0	.02	.02	.05	0	0	0	0	0	0
	1/2 After	0	0	0	.03	.1	0	0	.03	.03	0	0	.06
Right	1/2 Before	0	No Sample	0	0	/	.03	0	/	0	0	0	0
	1st hr.	0	.02	0	.02	0	0	0	.03	0	0	0	.03
	2nd hr.	0	0	0	.03	.03	.3	0	0	0	0	0	0
	3rd hr.	0	0	0	/	.02	0	/	0	0	0	0	0
	1/2 after	0	0	0	0	0	0	0	0	.03	0	0	.06
Rear	1/2 Before	0	No Sample	0	0	.2	0	0	0	0	.1	.07	.03
	1st hr.	0	0	0	.02	0	0	.03	.02	0	0	.08**	.12
	2nd "	0	0	0	0	.1	0	.08	.03	.02	0	0	.02
	3rd "	0	.02	0	0	.02	0	.02	0	.02	0	.07	.02
	1/2 after	0	0	0	0	.06	0	0	0	0	0	.01	0
External to Cone	1/2 Before				No Sample	.05	0	0	.06	.1	0	0	.1
	1st hr.				0	0	0	0	0	0	0	0	0
	2nd hr.				0	.03	0	0	0	0	0	.02	0
	3rd hr.				.02	0	0	0	0	0	0	0	0
	1/2 after				.03**	.1	.01	0	0	.01	0	.03	0

* - See Figure 1

** - Fungi included in total count

/ - Lab accident to plate

Table 2

Microbial Burden On Worktable Surface

		Colonies/Rodac Plate - Aerobic Mesophiles											
		C O N D I T I O N A			* C O N D I T I O N B			* C O N D I T I O N C			* C O N D I T I O N D		
Sampling Hour	Rodac Site*	Timer 1	Timer 2	Timer 3	Timer 4	Timer 5	Timer 6	Timer 7	Timer 8	Timer 9	Timer 10	Timer 11	Timer 12
1.	Left 1	1	0	0	1	50	1	4	16	1	0	0	0
	2	4	0	1	7	6	0	2	4	21	0	0	0
	Right 1	2	0	1	1	3	1	0	44	0	0	0	0
	2	2	1	0	0	4	2	6	3	0	0	0	0
	Left 1	7	5	0	0	0	0	1	11	0	0	0	0
	2	1	0	0	2	3	0	1	0	4	0	0	0
	Right 1	1	0	0	1	0	0	1	9	2	0	0	0
	2	8	0	0	0	0	0	1	0	2	0	0	1
3.	Left 1	0	0	0	0	1	0	13	5	3	1	0	0
	2	5	0	0	2	0	1	2	1	0	0	0	0
	Right 1	0	0	0	0	0	0	14	9	0	0	0	0
	2	2	0	0	1	0	0	0	5	1	1	0	0

* See Figure 1

Table 3

Microbial Burden on Stainless Steel Fallout Strips

		Viable Particles/ft. ² Surface - Aerobic Mesophiles - each Sampling Time									Average of six strips		
		Condition A*			Condition B*			Condition C*			Condition D*		
Exposure Time	Site*	Timer 1	Timer 2	Timer 3	Timer 4	Timer 5	Timer 6	Timer 7	Timer 8	Timer 9	Timer 10	Timer 11	Timer 12
Hour													
Control		0	0	0	0	0	0	0	0	0	0	0	0
1	Left	0	0	0	115	0	0	260	0	0	115	0	0
	Right	0	0	432	0	0	0	0	0	0	0	0	0
2	Left	0	0	0	115	115	216	0	115	0	0	0	0
	Right	0	0	0	0	0	0	0	72	260	0	43	0
3	Left	24	216	0	0	0	0	0	115	0	0	0	0
	Right	24	0	0	24	0	0	0	0	115	115	0	0

No Growth on Anaerobic Plates

* - See Figure 1.

Table 4

Microbial Burden on Stainless Steel Coupons Inside Cone

Viable Particles/Coupon - Aerobic Mesophiles - Av. of 2 Plates/Assay											
Exposure Time	Coupon Number*	Cone Area*	Condition B*			Condition C*			Condition D*		
			Timer 4	Timer 5	Timer 6	Timer 7	Timer 8	Timer 9	Timer 10	Timer 11	Timer 12
Hour	1	A	0	0	0	0	0	0	0	0	0
		B	0	0	0	0	0	0	0	0	0
		C	0	0	0	0	0	0	0	0	0
		F	0	0	0	0	0	0	0	5	0
	5	A	0	0	0	5	0	5	10	0	5
		B	0	0	0	0	0	0	0	0	0
		C	0	0	0	0	0	0	0	0	0
		F	10	0	5	0	0	0	0	0	0
	9	A	0	0	0	0	0	0	0	0	0
		B	0	0	0	0	0	0	0	0	0
		C	0	0	0	0	5	0	0	0	0
		F	0	0	0	0	0	0	0	0	0
	2.	A	0	0	0	0	0	0	5	0	0
		B	0	0	0	0	0	0	0	0	0
		C	0	0	0	25	0	0	0	0	0
		F	0	0	0	0	0	0	0	0	0
	6	A	0	0	0	0	0	0	0	0	0
		B	0	0	0	0	0	0	0	0	0
		C	0	5	0	0	0	0	0	0	0
		F	0	0	0	0	0	0	0	0	0
	10	A	0	10	5	5	0	0	0	0	0
		B	0	0	0	0	0	0	0	0	0
		C	0	0	0	0	0	0	0	0	5
		F	0	0	70	0	0	0	0	0	0
3.	3	A	0	0	0	0	0	0	0	0	0
		B	0	0	0	5	0	0	0	0	0
		C	0	0	0	0	45	0	0	0	0
		F	0	5	0	0	0	0	0	0	0
	7	A	0	0	5	0	0	0	0	0	0
		B	0	0	0	5	0	0	0	0	0
		C	0	5	0	0	0	0	0	0	0
		F	0	0	0	0	0	0	0	5	0
	11	A	0	0	0	0	0	0	5	0	0
		B	0	0	0	0	0	0	11	0	0
		C	5	0	0	0	0	0	0	0	0
		F	108	0	5	0	0	0	0	0	0

*See Figure 3

Table 5

Microbial Burden On Assay Groups* of Timers

Assay Group Number*	Viable Particles/Assay Group* - Aerobic Mesophiles - Ave. 2 Plates/Assay Vegetative Cells											
	Condition A**			Condition B**			Condition C**			Condition D**		
	Timer 1	Timer 2	Timer 3	Timer 4	Timer 5	Timer 6	Timer 7	Timer 8	Timer 9	Timer 10	Timer 11	Timer 12
1	0	0	0	0	0	(5) 5	5	15	0	---	10	20
2	0	0	0	0	0	0	5	0	0	---	10 ⁽¹⁰⁾	20
3	0	0	0	0	0	0	0	0	0	---	0	0
4	0	0	0	0	0	0	0	0	0	---	0	0
5	0	0	0	(5) 5	0	0	40	0	0	---	0	5
6	0	0	0	0	0	0	0	10	0	---	0	5
7	10	0	0	0	(30) 30	0	0	25 ⁽²⁰⁾	0	---	0	50
8	0	0	0	0	0	0	0	5 ⁽⁵⁾	0	---	0	0
9	0	10	0	0	5	0	0	0	0	---	0	0
10	0	0	0	0	0	0	0	5 ⁽⁵⁾	0	0	0	10
11	0	0	5	0	0	0	5	30 ⁽²⁰⁾	0	0	0	5
12	0	0	0	0	0	0	0	5	0	100 ⁽¹⁰⁰⁾	0	0
13	0	0	0	0	0	0	5	0	0	0	0	0
14	(5) 5	0	40***	0	0	280***	5	5 ⁽⁵⁾	0	0	0	10
15	5	0	0	0	0	0	0	5	0	0	0	0
16	5 ⁽⁵⁾	20	0	5 ⁽⁵⁾	0	0	0	0	5	0	0	0
17	0	0	0	0	0	5	0	0	0	0	0	0
18	10	0	0	5 ⁽⁵⁾	0	0	0	0	0	0	0	0
19	0	10 ⁽¹⁰⁾	0	0	0	5 ⁽⁵⁾	0	0	0	0	0	0
20	5 ⁽⁵⁾	0	0	30	140	0	10	10	0	25 ⁽²⁵⁾	0	0
Total/Timer	30	45	0	45	180	15	75	115	5	125	20	125

No Growth on Anaerobic Plates

* - See Figure 2

** - See Figure 1

() - Spore Count

*** - This part possibly contaminated in sonicator tank

--- - Assembly could not be completed due to difficulty in assembling previous parts.

Table 6

The Difference in Microbial Burden in the EASL Intramural
Air Under Variations of Vertical Downflow

EASL Environment		Particles/ft. 3	Significance
Condition B:	Assembler/Worktable Under Cone	0.04**	
Condition D:	Assembler Under Cone Worktable at Edge Horiz. Laminar Flow	0.02**	
Condition C:	Assembler Under Cone Worktable at Edge	0.01**	
Condition A:	EASL Within Spec.	0.001**	

* Analysis of data by Student's "t" Test. - Significance level = .05
 ** These values represent the arithmetic averages of all values obtained from the intramural air samplings under each set of conditions.

T A S K 12

REFERENCES

1. Jet Propulsion Laboratory Specification XOY-50543-GEN
(Revision) August 15, 1967.
2. Standard Procedures for the Microbiological Examination
of Space Hardware, NASA Headquarters, Washington DC.,
June 1, 1966.

APPENDIX A

ASSEMBLY OPERATION SEQUENCE

PART NO. 100 - HOUSING ASSEMBLY

OP. NO.

10. ASSEMBLE PART NO. 60-1 STOP ARM ON SMOOTH POST OF PART NO. 90 HOUSING, FOLLOW WITH PART NO. 50-1 FLAT WASHER. COMPLETE ASSEMBLY BY ALTERNATING PART NOS. 60-2 THRU 60-10 AND PART NOS. 50-2 THRU 50-10.
20. ASSEMBLE PART NOS. 40-1 SPRING THRU 40-10 ON SERRATED POST OF PART NO. 90 HOUSING. DO NOT INSERT SPRING UNDER 60-1 THRU 60-10 STOP ARM UNTIL COMPLETION OF OPERATION NO. 3.
30. ASSEMBLE PART NO. 80 HOLDING RING TO PART NO. 90 HOUSING USING (3) NO. 70 SCREW.

APPENDIX A

ASSEMBLY OPERATION SEQUENCE

PART NO. 200 DRIVE SHAFT ASSEMBLY

OP. NO.

10. ASSEMBLE PART NO. 110-1 SPRING, FLAT ON PART NO. 190 DRIVE SHAFT, FOLLOW WITH PART NO. 120-1 FLAT WASHER AND PART NO. 130-1 STOP RING. CONTINUE WITH THIS SEQUENCE FOR PART NOS. 110-2 THRU 110-10, PART NO. 120-2 THRU 120-10, AND PART NOS. 130-2 THRU 130-10.
20. ASSEMBLE PART NO. 180 LOCK RING (SPANNER TYPE), ON PART NO. 190 DRIVE SHAFT AND SCREW LOCK IN POSITION. ASSEMBLE (2) PART NO. 140 FLAT WASHER (DRIVE SHAFT LOWER).
30. ASSEMBLE PART NO. 170 LOCATING RING TO PART NO. 190 DRIVE SHAFT THEN INSERT PART NO. 160 DRIVE PIN. ASSEMBLE (2) PART NO. 150 FLAT WASHERS (DRIVE SHAFT TOP).

ASSEMBLY OPERATION SEQUENCE

PART NO. 300 TOP ASSEMBLY

OP. NO.

10. ASSEMBLE PART NO. 200 DRIVE SHAFT ASSY. TO PART NO. 100 HOUSING ASSY. INSERT PART NO. 40-1 THRU 40-10 SPRING (LOCK ARM) UNDER PART NO. 60-1 THRU 60-10 LOCK ARM IN PART NO. 100 HOUSING ASSY.
20. ASSEMBLE PART NO. 295 CALIBRATION GEAR HOUSING TO PART NO. 200 DRIVE SHAFT ASSY. INSERT PART NO. 285 PIN DRIVE SHAFT LOCK INTO PART NO. 200 DRIVE SHAFT ASSY.
30. ASSEMBLE PART NO. 290 LOCK, DRIVE SHAFT USING (2) PART NO. 280 SCREWS, ALLEN.
40. ASSEMBLE PART NO. 275 HOUSING GEAR TO PART NO. 200 DRIVE SHAFT ASSY. AND PART NO. 100 HOUSING ASSY.
50. ASSEMBLE PART NO. 265 GEAR, ROLLER BEARING TO PART NO. 200 DRIVE SHAFT ASSY. INSERT PART NO. 255 PIN, KEEPER INTO DRIVE SHAFT.
60. ASSEMBLE PART NO. 260 RING, HOLDING, PART NO. 250 SPRING, PRESSURE, PART NO. 245 WASHER BEARING AND PART NO. 240 BEARING (LOWER DRIVE SHAFT).
70. ASSEMBLE (4) PART NO. 235 POST, STAND-OFF TO PART NO. 100 HOUSING ASSY. USING (3) PART NO. 230 SCREW, (POST, STAND-OFF) AND (1) PART NO. 225 SCREW, POST (POST, STAND-OFF) WITH (4) PART NO. 215 WASHER, FLAT KEY.
80. ASSEMBLE PART NO. 220 PLATE, LOWER (CASTING) TO DRIVE SHAFT AND PART NO. 235 POST, STAND-OFF USING (4) PART NO. 210 STAND-OFF, THREADED.

APPENDIX A

EASL Environments during construction.

<u>Timer Number</u>	<u>EASL Condition</u>
1, 2 and 3	EASL on environmental specification
4, 5 and 6	EASL at 83°F and 20-25% R.H.
7, 8 and 9	EASL at 83°F and 45% RH or as close to 45% as possible.
10, 11 and 1	EASL on specification for temperature and relative humidity but blowers shut down during construction of the timers

Sequence of timer construction

1. Timer will be assembled in the following chronological order:

Assembly

1st	Timer #1	7th	Timer #8
2nd	Timer #4	8th	Timer #9
3rd	Timer #5	9th	Timer #3
4th	Timer #6	10th	Timer #10
5th	Timer #2	11th	Timer #11
6th	Timer #7	12th	Timer #12

APPENDIX B

DISASSEMBLY OPERATION SEQUENCE *

PART NO. 300 TOP ASSEMBLY

OP. NO.

10. DISASSEMBLE (4) PART NO. 210 STAND-OFF, THREADED, (1) PART NO. 220 PLATE, LOWER (CASTING), (3) PART NO. 230 SCREW POST, STAND-OFF), (1) PART NO. 225 SCREW, POST (POST, STAND-OFF) (4) PART NO. 215 WASHER, FLAT KEY AND (4) PART NO. 235 POST STAND-OFF.

ASSAY GROUP (1) THRU (3)

1. (4) #210 STAND-OFF THREADED, (3) SCREW
(1) #225 SCREW, POST AND (4) #235 POST, STAND-OFF
2. (1) #220 PLATE, LOWER (CASTING).
3. (4) #215 WASHER, FLAT KEY.

* This operation was performed at a horizontal laminar flow bench.

APPENDIX B

OP. NO.

20. DISASSEMBLE (1) PART NO. 240 BEARING (LOWER DRIVE SHAFT),
(1) PART NO. 245 WASHER, BEARING, (1) PART NO. 250 SPRING,
PRESSURE, (1) PART NO. 260 RING, HOLDING, (1) PART NO. 255
PIN, KEEPER, (1) PART NO. 265 GEAR, ROLLER BEARING, (1) PART
NO. 275 HOUSING GEAR.

ASSAY GROUP (4) THRU (7)

4. (1) #240 BEARING, (1) #245 WASHER, BEARING,
(1) #255 PIN KEEPER AND (1) #260 RING HOLDING
5. (1) #250 SPRING, PRESSURE.
6. (1) #256 GEAR, ROLLER BEARING
7. (1) #275 HOUSING, GEAR.

APPENDIX B

OP. NO.

30. DISASSEMBLE (2) PART NO. 280 SCREW, ALLEN, (1) PART NO. 290 LOCK, DRIVE SHAFT, (1) PART NO. 295 CALIBRATION GEAR HOUSING AND (1) PART NO. 285 PIN, DRIVE SHAFT LOCK.

ASSAY GROUP (8)

8. (2) #280 SCREW, ALLEN, (1) #290 LOCK, DRIVE SHAFT, (1) #285 PIN, DRIVE SHAFT LOCK AND (1) #295 CALIBRATION GEAR HOUSING.

APPENDIX B

OP. NO.

40. DISASSEMBLY PART NO. 200 DRIVE SHAFT SUB-ASSY. FROM PART NO. 100 HOUSING ASSY. BY RELEASING THE SPRING TENSION ON THE (10) LOCK ARMS.
50. DISASSEMBLE THE NO. 200 DRIVE SHAFT ASSY. AS FOLLOWS:
REMOVE (5) PART NO. 140 WASHER, FLAT (DRIVE SHAFT LOWER),
(2) PART NO. 150 WASHER, FLAT (DRIVE SHAFT TOP). REMOVE
PART NO. 160 DRIVE PIN FROM PART 170 LOCATING RING AND
PART NO. 190 DRIVE SHAFT. SLIP LOCATING RING FROM DRIVE
SHAFT. REMOVE PART NO. 180 LOCK RING. DISASSEMBLE THE
(10) PART NO. 130-1 THRU-10 STOP RINGS, (10) PART NO. 110-1
THRU-10 SPRINGS AND (9) PART NO. 120-1 THRU-9 WASHERS FLAT

ASSAY GROUP (9) THRU (14)

9. (5) #140 WASHERS, FLAT (DRIVE SHAFT LOWER) AND
(2) #150 WASHERS, FLAT (DRIVE SHAFT TOP).
10. (1) #160 DRIVE PIN, (1) #170 LOCATING RING AND
(1) #180 LOCK RING.
11. (10) #130-1 THRU-10 STOP RING.
12. (10) #110-1 THRU-10 SPRINGS
13. (9) #120-1 THRU-9 WASHERS, FLAT
14. (1) #190 DRIVE SHAFT.

APPENDIX B

OP. NO.

60. DISASSEMBLE THE PART NO. 100 HOUSING SUB-ASSY AS FOLLOWS:

REMOVE (3) PART NO. 70 SCREWS FROM PART NO. 80 HOLDING RING AND PART NO. 90 HOUSING. USING SCREW DRIVER REMOVE PART NO. 80 HOLDING RING. FROM THE HOUSING POST SLIP OFF (10) PART NO. 50-1 THRU 50-10 WASHER, FLAT AND (10) PART NO. 60-1 THRU 60-10 LOCK ARMS. FROM THE OPPOSITE HOUSING POST REMOVE (10) PART NO, 40-1 THRU 40-10 SPRINGS.

ASSAY GROUP (15) THRU (20)

- 15. (3) #70 SCREWS
- 16. (1) #80 HOLDING RING
- 17. (10) #61-1 THRU-10 LOCK ARMS
- 18. (10) #50-1 THRU-10 WASHERS FLAT.
- 19. (10) #40-1 THRU-10 SPRINGS
- 20. (1) #90 HOUSING.

APPENDIX C

PARTS LIST

SUB-ASSY. #100

<u>PART NO.</u>	<u>QTY.</u>	<u>NOMENCLATURE</u>
100	1	HOUSING ASSEMBLY
90	1	HOUSING
80	1	HOLDING RING
70	3	SCREW (HOLDING RING)
60-1	1	LOCK ARM
-2	1	LOCK ARM
-3	1	LOCK ARM
-4	1	LOCK ARM
-5	1	LOCK ARM
-6	1	LOCK ARM
-7	1	LOCK ARM
-8	1	LOCK ARM
-9	1	LOCK ARM
-10	1	LOCK ARM
50-1	1	FLAT WASHER
-2	1	FLAT WASHER
-3	1	FLAT WASHER
-4	1	FLAT WASHER
-5	1	FLAT WASHER
-6	1	FLAT WASHER
-7	1	FLAT WASHER
-8	1	FLAT WASHER
-9	1	FLAT WASHER
-10	1	FLAT WASHER

APPENDIX C

PARTS LIST

SUB-ASSY #100 CONT.

<u>PART NO.</u>	<u>QTY.</u>	<u>NOMENCLATURE</u>
40-1	1	SPRING (LOCK ARM)
-2	1	
-3	1	
-4	1	
-5	1	
-6	1	
-7	1	
-8	1	
-9	1	
-10	1	

APPENDIX C
PARTS LIST
SUB-ASSY #200

<u>PART NO.</u>	<u>QTY.</u>	<u>NOMENCLATURE</u>
200	1	DRIVE SHAFT
190	1	DRIVE SHAFT
180	1	LOCK RING (SPANNER TYPE)
170	1	LOCATING RING (DRIVE SHAFT)
160	1	DRIVE PIN
150	1	FLAT WASHER (DRIVE SHAFT TOP)
140	5	FLAT WASHER (DRIVE SHAFT LOWER)
130-1	1	STOP RING
-2	1	STOP RING
-3	1	STOP RING
-4	1	STOP RING
-5	1	STOP RING
-6	1	STOP RING
-7	1	STOP RING
-8	1	STOP RING
-9	1	STOP RING
-10	1	STOP RING

APPENDIX C
PARTS LIST
SUB-ASSY #200, CONT.

<u>PART NO.</u>	<u>QTY.</u>	<u>NOMENCLATURE</u>
120-1	1	FLAT WASHER (STOP RING)
-2	1	FLAT WASHER (STOP RING)
-3	1	FLAT WASHER (STOP RING)
-4	1	FLAT WASHER (STOP RING)
-5	1	FLAT WASHER (STOP RING)
-6	1	FLAT WASHER (STOP RING)
-7	1	FLAT WASHER (STOP RING)
-8	1	FLAT WASHER (STOP RING)
-9	1	FLAT WASHER (STOP RING)
110-1	1	SPRING, FLAT (STOP RING)
-2	1	SPRING, FLAT (STOP RING)
-3	1	SPRING, FLAT (STOP RING)
-4	1	SPRING, FLAT (STOP RING)
-5	1	SPRING, FLAT (STOP RING)
-6	1	SPRING, FLAT (STOP RING)
-7	1	SPRING, FLAT (STOP RING)
-8	1	SPRING, FLAT (STOP RING)
-9	1	SPRING, FLAT (STOP RING)
-10	1	SPRING, FLAT (STOP RING)

APPENDIX C
PARTS LIST
ASSEMBLY #300

<u>PART NO.</u>	<u>QTY.</u>	<u>NOMENCLATURE</u>
300	1	TOP ASSEMBLY
100	1	HOUSING ASSY.
200	1	DRIVE SHAFT ASSY.
295	1	CALIBRATION GEAR HOUSING
290	1	LOCK DRIVE SHAFT
285	1	PIN, DRIVE SHAFT LOCK
280	1	SCREW, ALLEN
275	1	HOUSING, GEAR
265	1	GEAR, ROLLER BEARING
260	1	RING, HOLDING
255	1	PIN, KEEPER
250	1	SPRING PRESSURE
245	1	WASHER, BEARING
240	1	BEARING (LOWER DRIVE SHAFT)
235	4	POST, STAND-OFF
230	3	SCREW (POST, STAND-OFF)
225	1	SCREW, POST (POST, STAND-OFF)
220	1	PLATE, LOWER (CASTING)
215	4	WASHER, FLAT KEY
210	4	STAND-OFF THREADED

APPENDIX C

BIO ASSAY GROUPS PARTS LIST

(#300 Timer Assembly)

1. (4) #210 STAND-OFF THREADED, (3) #230 SCREW
(1) #225 SCREW, POST AND (4) #235 POST, STAND-OFF
2. (1) #220 PLATE, LOWER (CASTING)
3. (4) #215 WASHER, FLAT KEY
4. (1) #240 BEARING, (1) #245 WASHER, BEARING
(1) #255 PIN, KEEPER AND (1) #260 RING, HOLDING.
5. (1) #250 SPRING, PRESSURE
6. (1) #265 GEAR, ROLLER BEARING.
7. (1) #275 HOUSING, GEAR
8. (2) #280 SCREW, ALLEN, (1) #290 LOCK, DRIVE SHAFT
#285 PIN DRIVE SHAFT LOCK AND (1) #295 CALIBRATION GEAR HOUSING
9. (5) #140 WASHERS, FLAT (DRIVE SHAFT LOWER) AND
(2) #150 WASHER, FLAT (DRIVE SHAFT TOP)
10. (1) #160 DRIVE PIN, (1) #170 LOCATING RING AND
(1) #180 LOCK RING.
11. (10) #130-1 THRU-10 STOP RING
12. (10) #110-1 THRU-10 SPRINGS
13. (9) #120-1 THRU-9 WASHERS, FLAT
14. (1) #190 DRIVE SHAFT
15. (3) #70 SCREWS
16. (1) #80 HOLDING RING
17. (10) #61-1 THRU-10 LOCK ARMS
18. (10) #50-1 THRU-10 WASHERS, FLAT
19. (10) #40-1 THRU-10 SPRINGS
20. (1) #90 HOUSING